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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—IX.

THE MIAMI CLAY LOAM.

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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—IX.

THE MIAMI CLAY LOAM.

GEOGRAPHICAL DISTRIBUTION.

The Miami clay loam is chiefly found in the eastern portion of the north-central States. It is most extensively developed in Indiana, Michigan, and Ohio, though small areas are found in Wisconsin and Iowa. The soil type has been mapped to the extent of 2,281,482 acres in 18 areas in the five States in which it has been encountered. The soil surveys in question have been so distributed that they practically outline the region within which it may be anticipated that additional areas of this soil will be found. It is improbable that any extensive areas of the Miami clay loam will be found east of Cleveland, Ohio, south of Dayton, Ohio, or Indianapolis, Ind., or west of Rockford, Ill. The soil surveys already completed, however, indicate that the Miami clay loam constitutes one of the dominant soils of central and western Ohio, northeastern Indiana, and southern Michigan. From all of the localities where this type has been encountered in the soil surveys, its area has extended into bordering counties, indicating the existence of many millions of acres of the type within the region outlined.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The surface soil of the Miami clay loam is a brown, yellow, or gray silty loam. The depth of this surface soil is rarely less than 6 inches, except in limited areas on steep slopes where erosion has been active. More frequently the depth is greater than 10 inches, constituting an unusually deep surface soil. This material is frequently underlain by a yellow or brown heavy silty loam to a depth of about 2 feet, and this in turn is underlain by a brown, yellow, gray, or drab, frequently mottled, silty clay loam or heavy clay. At a depth varying from 2 feet to 5 or 6 feet the typical blue or drab bowlder clay, with the characteristic glacial pebbles and bowlders, is almost universally encountered. Only upon slopes and in other localities where the depth of surface soil and subsoil is unusually shallow will the consolidated underlying rock be encountered. Usually the depth of the glacial till to bedrock is from 40 to 150 feet. The Miami clay

loam is, therefore, merely the surface expression, in the form of soil, of deep, complex, mechanically broken soil-making material of glacial origin. The soil itself has been slowly prepared through the processes of the weathering of the surface portion of this material. The glacial origin of the soil, insuring the commingling of earthy material from a great variety of sources, the great depth of the soil-making material, and the compact nature of the mass which resists excessive erosion all tend to form a soil of medium to good fertility and of a most durable quality under even fair conditions of agricultural occupation.

In many regions where the Miami clay loam is found, scattered bowlders and smaller stone will be found locally over the surface of the type, and in increasing quantities in the deeper subsoil and underlying till. In some areas of limited extent this accumulation of stone may be sufficient to interfere somewhat with cultivation. In such cases the stone has usually been gathered from the field and built into boundary fences or into the walls of buildings. In general, however, the surface soil is fairly free from any large masses of rock or extensive accumulations of stone and gravel. The character of the larger rock masses found associated with the Miami clay loam roughly indicates the character of the finer-grained soil-forming material. The bowlders, stone, and gravel comprise fragments of practically every known variety of igneous, metamorphic, and sedimentary rock occurring within the area occupied by the soil type or found in extensive tracts to the north, from which the glacial ice passed southward to deposit its load. Granites, gneisses, schists, sandstone, limestone, and quartzite are all found among the glacial bowlders and pebbles. The softer rocks like shale have usually been so finely ground by glacial action as to prevent identification in the majority of areas. Locally, however, where the rock of the region has consisted of shale, considerable proportions of this material may be found in the deeper subsoil. In all such areas, which are found chiefly in the eastern extension of the region occupied by the Miami clay loam, that type of soil is grading in its origin and in the character of its constituent materials toward the soils of the Volusia series found in extreme northeastern Ohio, in northwestern Pennsylvania, and in southwestern New York.

The Miami clay loam and the other soils of the Miami series are characterized by their derivation through surface weathering from deep glacial till, by the presence of a diversity of crystalline and sedimentary rocks in the form of bowlders, stone, and pebbles, and, in conjunction with this origin, by the light colored, either brown or yellow, surface soils. The soils of the Miami series differ from those of the Carrington series, similarly derived, in that the latter are marked by black surface soils; and from the soils of the Coloma series, which are light colored,

on account of the fact that these are chiefly formed by the glaciation of easily disintegrated sandstone. They also differ from the light-colored silty soils of the Knox series and the black silty soils of the Marshall series in that both of the latter series are almost without exception stone free and lack even pebbles or small bowlders. The materials from which the soils of the Miami series are derived are chiefly unstratified and massive, while the materials giving rise to the soils of the Plainfield and Waukesha series are formed by the action of outflowing glacial waters and by modification through subsequent wind action.

SURFACE FEATURES AND DRAINAGE.

Considering the wide extent of territory over which the Miami clay loam is developed and also holding in mind its derivation from ice-laid materials, the surface configuration of the type is unusually uniform, or at least varies within reasonably narrow limits. In general, the surface of the type consists of gently undulating or slightly rolling surface features which only become accentuated locally into the form of low, rounded hills or steep-sided knobs in such locations as are occupied by distinct glacial moraines. The only other hilly or steeply sloping portions of the Miami clay loam are those found where postglacial streams have cut deeply below the glaciated upland surface, and have extended their minor branches through the area occupied by the Miami clay loam. Such regions are occasionally found even farther west than the territory principally occupied by the type and constitute the greater proportion of the Miami clay loam to be found in Iowa and other west-central States.

The altitudes at which the type has been developed vary from approximately 600 feet above tide level in the vicinity of Lakes Erie and Michigan to altitudes of a little more than 1,000 feet in more southern locations. These differences in altitude arise chiefly from differences in the elevation of the rock floor over which the glacial materials have been laid down. The surface of the soil type itself rolls gently upward from its lower elevations to the highest altitudes attained near the southern boundary of glaciation in central and southwestern Ohio.

There is considerable variation in the natural drainage features of the Miami clay loam; the more level areas, and especially those somewhat remote from lines of pronounced stream drainage, are inclined to be wet and poorly drained. This arises both from the level surface condition of the soil and from the considerable depth of the massive, stiff glacial clay from which the soil itself has been formed. Thus, both surface drainage and the internal soil and subsoil drainage are deficient over such areas. In the more rolling portions, such as comprise extensive areas in southern Michigan, west-central Ohio, and

eastern Indiana, the drainage of the type is unusually good, and for this reason it was frequently selected for early settlement in the pioneer days. In no case is the drainage of the Miami clay loam excessive.

Erosion constitutes a soil problem only upon the steeper sloping areas of the Miami clay loam found where the soil breaks sharply from the general upland level down to the valley of some deeply incised stream course. Such areas are usually maintained in forests or woodlot, or at most are occupied for permanent pasture, so that the erosion problem upon the areas of this type is scarcely worthy of serious consideration.

LIMITATIONS OF USES.

The heavy silty loam of the surface soil and stiff compact subsoil of the Miami clay loam render it unfavorable to the production of any of the early vegetable or fruit crops produced for general market purposes. Even Irish potatoes are practically excluded from production upon this type as a commercial crop because of the fine-grained texture of the soil and its tendency to bake and clod unless the surface is kept thoroughly stirred. Under such conditions the production of large yields of marketable potatoes can only be secured by the most careful preparation of the land and the most thorough tillage during the growth of the crop.

The organic matter content of the surface soil of the Miami clay loam varies considerably with the surface slope of the type, and with its relationship to natural drainage. In lower lying hollows and at the lower altitudes there is a tendency toward the accumulation of organic matter, evinced by the darker-brown coloring of the surface soil and frequently by its more mealy and friable structure. In such locations the material is grading toward the soils of the Carrington series, the black clay member of which is almost constantly associated with this type. Over the greater part of the area of the Miami clay loam the surface soil is a yellow, brown, or gray in color. In such areas a moderate amount of organic matter is still maintained within the surface soil and the best conditions for crop production are thus indicated. Upon steep slopes, where erosion has been active, the surface soil is frequently lacking and the brown, pale-yellow, ash-colored, or blue subsoil material is exposed. Very little organic matter is found in the surface materials over such areas and the incorporation of organic manures should be accomplished. In general, the Miami clay loam is found to contain about an average quantity of organic matter for upland glacial soils, particularly in timbered regions.

All areas of the Miami clay loam mapped lie within the cool temperate region of the central United States under conditions of abun-

dant but not excessive rainfall. This fact, coupled with the fine texture and dense structure of the soil material itself, limits the best uses of the soil to the production of general farm crops, particularly to the small grains and grasses. Thus the Miami clay loam is a general farming soil rather than a special purpose soil, and the crop adaptations later enumerated will indicate a strong tendency toward the production of small grains throughout all the regions where the type has been encountered.

IMPROVEMENT IN SOIL EFFICIENCY.

Judging from the increased yields of the general farm crops secured upon such tracts as have been adequately tile-drained, this should constitute one of the most important methods of improvement of the present condition of the Miami clay loam. Particularly where the surface features are level to gently undulating, where farm lands are remote from deeply cut stream trenches, or where depressions exist over the surface of the type, the installation of tile drains is of fundamental importance for the proper utilization of this soil. The contrasts in crop yields between properly drained and poorly drained areas of the type, whether this drainage has been accomplished naturally or through the installation of tile, are marked. With adequate drainage the Miami clay loam ranks high, not only for the production of winter wheat, oats, and grass, but also as a corn-producing soil. On the other hand, where drainage is deficient the production of corn and of winter wheat is rendered practically impossible, or else the yields secured are too small to justify the production of these crops. There are areas of the Miami clay loam, particularly in the more eastern States where it has been encountered, which because of poor drainage have not been cleared and brought under cultivation until within the last half century and then only through the installation of open ditches and of systems of tile drainage. Flat areas which have not been so treated still produce small crop yields where they are farmed and do not possess that wide range of cropping possibility which is essential to a well-balanced system of general farming. The cost of tile-draining a stiff impervious soil of this character, and especially one where the deeper subsoil is liable to contain considerable masses of stone or even large bowlders, is rather high, ranging from $20 to $30 an acre for the complete drainage of entire fields. Nevertheless, when this is considered as an investment adding to the permanent value of the land, it is usually justified, not only by the increased crops secured, but also by the rapidly increasing value of the land itself. Tile drains to be effective upon the Miami clay loam should have considerable internal diameter and adequate fall along the ditch line and should be placed at rather frequent intervals and at an average

depth of not less than 3 feet. These requirements give rise to the rather high cost of adequate underdrainage of the type.

The frequent incorporation of a reasonable amount of organic matter in the surface soil is also requisite to maintain or to increase the efficiency of the Miami clay loam. The prevalent systems of farming upon the type are fairly adequate for this purpose in that grass constitutes an important crop in the regular rotation followed over practically the entire area of this soil. The plowing under of the sod in the preparation of the land for corn or other hoed crops assists in the maintenance of organic matter in the soil, while the keeping of live stock and of dairy cows upon the areas of this type also renders possible the application of stable manure over a considerable proportion of the arable acreage each year. The better farmers throughout the section occupied by the Miami clay loam practice these methods of organic matter restoration and are amply repaid by maintained and even increased crop yields.

In connection with the production of the grass crops, particularly the clovers, the application of lime to this dense, compact soil is found to produce excellent increases in the crop yields wherever it has been properly attempted. Either finely ground limestone rock or the burned stone-lime may be used for this purpose. In case the powdered limestone is used, considerably larger applications are required than in the case of the stone-lime. In the latter case applications of 1,500 to 2,000 pounds per acre produce paying increase in the yield of clover hay. At least double this quantity of ground limestone would need to be applied in order to secure the same results.

Another method for securing improvement in the crop yields of the Miami clay loam would consist in the maintenance of the most perfect tilth possible in the surface soil. The fine texture of the surface soil gives rise to a tendency toward clodding and baking unless the land is handled when the moisture conditions both in surface soil and subsoil are particularly favorable. Plowing should not be attempted either when the soil is thoroughly baked and hardened nor when it is wet and soft. In the former case large clods are liable to be formed, which it is very difficult to break down into favorable condition by any subsequent operations of tillage. In the latter case both the surface soil and the subsoil at plow depth are likely to become puddled and to form a "hardpan" or other unfavorable physical condition for the processes of root growth. A little care in the plowing of this land when it is in the condition of optimum moisture content will usually obviate both of these difficulties. It should be held in mind, moreover, by every owner of land of this character that the soil resources locked up in the baked and hardened clods are absolutely unavailable for the use of the growing

crops, besides constituting a danger in the cultivation of the intertilled crops through the breaking down of the young plants. Thorough harrowing, preferably with the disk harrow, will frequently serve to break up the surface clods, and some such tillage implement is required for the perfect preparation of the land.

LIMITATIONS UPON SPECIAL CROPS.

There are few special crops which are suited to production upon the Miami clay loam, and the best types of agriculture conducted upon this soil are those embodying the production of grain and grass and the utilization of these for dairying and stock feeding. Upon the more rolling portions, especially where the low hills of the morainal belt are to be found, apple orcharding may be undertaken upon a small scale. Even in such areas the heavy texture of the soil and the dense subsoil limit the varieties which may be produced. Pears constitute the only other orchard fruit that is well suited to a soil of such heavy texture.

Tobacco is produced upon the Miami clay loam in southern and southwestern Ohio upon areas which are particularly well drained, which have been heavily manured and fertilized, and which have been brought into excellent mechanical condition by careful tillage. These constitute practically the only special crops which are suited to production upon the Miami clay loam, both because of its textural peculiarities and because of its climatic location.

EXTENT OF OCCUPATION.

The Miami clay loam, locally known as the "maple land" or the "walnut land," from the dominant species of the native hardwood trees, was early sought for clearing and settlement during the pioneer days in Michigan, Ohio, and Indiana. The type supported a heavy growth of a great variety of hardwood trees. Throughout Ohio it bore forests of oak, maple, beech, basswood, walnut, poplar, cherry, ash, elm, hickory, black gum, buckeye, and ironwood. In localities where the maple or walnut prevailed, the type early attained a considerable reputation for its fertility and sustained crop-producing power. In general the lands occupied by a prevalent beech forest were not so highly esteemed, while the lands occupied by the black gum and elm usually indicated low-lying areas within the type which did not possess natural drainage adequate to permit of their immediate occupation.

These timbered lands throughout the east-central States were first sought for pioneer occupation, not only because of the prevalence of the timber suitable for the building of all farm structures and of fences, but also because the open prairies and glades were

usually swampy and covered with water during a considerable portion of the year. It was easier for the pioneer settler to clear the heavy timber growth and to raise his crops among the stumps than it was to drain and reclaim the lower lying marshy lands. The question of the more healthful situation of the broad areas of the Miami clay loam also frequently directed settlement to the regions where it prevailed. Consequently, over a considerable proportion of the territory occupied by this type, the Miami clay loam was early cleared and occupied by farms. Usually the clearing proceeded gradually, and for a long period of time a considerable proportion of the area in farms was still occupied by hardwood timber, while smaller proportions were being brought under the plow. With the progress of agricultural occupation these forest areas have now been reduced to small woodlots, but still over a considerable part of the region each farm is provided with its woodlot and frequently with its "sugar-bush" in the sugar maple section.

The gently undulating or rolling surface of the Miami clay loam presented no topographic difficulties to prevent its agricultural occupation. Consquently as the timber was removed, larger and larger areas were occupied by farm crops, and at present over 80 per cent of the extent of the type is either arable land or is held in more or less permanent pastures, which are occasionally plowed for the production of a crop and for the restoration of the seeding to grass. The balance of the type consists of the woodlot tracts already mentioned, somewhat hilly and stony areas which are occasionally found within the type, and of those steeper slopes along its margins where the upland surface breaks down to the deeply trenched streams.

In general the Miami clay loam is highly prized as an agricultural soil and its valuation varies, depending upon its location with respect to market and to transportation, from $50 or $60 an acre to $125 or even $150 or more where the land is located near the outskirts of the larger manufacturing cities.

There is thus little possibility that the area of the Miami clay loam under cultivation may be greatly extended. Such extension may only occur through the draining of areas which still remain somewhat swampy or through the cutting away of forested areas which are really required for the annual use of the farms upon which they occur. The former improvement might well be undertaken. The clearing of woodlots could scarcely be called an improvement.

CROP ADAPTATIONS.

The Miami clay loam is principally devoted to the production of corn, wheat, oats, and hay. Of the grain crops the acreage of corn takes first rank and the crop is universally grown upon this type of soil in Indiana, Michigan, Ohio, and Wisconsin. In general the dent

varieties of corn, either white or yellow, are produced in the more southern regions, while to a limited extent in Michigan, the flint corn is also grown upon this type. In Indiana the yields of corn upon the Miami clay loam range from 25 to 60 bushels per acre with an average yield in excess of 45 bushels per acre. In Michigan the yields range from 25 to 50 bushels, with an average yield of about 30 bushels per acre. In Ohio, corn upon the Miami clay loam produces from 30 to 60 bushels per acre, with an average yield of about 40 bushels. In Wisconsin, the yield is 25 to 40 bushels per acre, with the average about 35 bushels. In the areas where the Miami clay loam has been mapped in Indiana the acreage annually devoted to corn exceeds that devoted to any other grain crop, although wheat is second in acreage and oats are third. In Ohio, the acreage devoted to corn is usually first, although in some instances this is exceeded by either wheat or oats; while in Michigan the larger area of the type is usually devoted to wheat, with corn second in acreage and oats third. In general, the Miami clay loam is not considered quite as good a corn soil as the Carrington black clay loam, or the Marshall silt loam, when these occur in the same areas where the Miami clay loam is found. It is, however, an excellent corn soil, measured by the average yields produced, even in the great corn-growing region of the central prairie States, and with proper drainage and careful preparation of the lands annual yields averaging from 45 to 50 bushels may be expected. The corn is usually planted upon old sod, which has been turned under, and not infrequently applications of stable manure are also made prior to the production of this crop. In general, the Miami clay loam occupies a region in west-central Ohio and east-central Indiana, where the average production of corn is in excess of 40 bushels per acre. The only regions of any extent which exceed this yield are those somewhat farther to the west, which are principally occupied by the Marshall silt loam. Thus the Miami clay loam may be ranked as one of the dominant corn soils in the United States.

The majority of farmers consider the Miami clay loam even better suited to the production of wheat than to the growing of corn. Of the total area of the Miami clay loam which has thus far been mapped by the Bureau of Soils the counties in which the type constitutes more than one-half of the total area show an acreage devoted to wheat only less than that devoted to corn, and the computed average yield of wheat per acre in such counties in Indiana and Ohio is a trifle in excess of 17 bushels. Wheat yields in these States have been reported during the progress of the soil survey as ranging from 15 to 25 or 30 bushels per acre, and it is probable that the average for the Miami clay loam considerably exceeds the average for the counties in which it occurs, since in each case it constitutes the best wheat soil of the area. Usually wheat is seeded upon ground where corn has been produced the previous year. The winter varieties only are grown, spring

wheat being practically unknown in this section. In Michigan the area devoted to wheat usually exceeds that devoted to any other grain crop upon this soil type, and the average yields upon all soils in the counties of which soil surveys have been made are in the vicinity of 13 bushels per acre. The yields reported from this soil type in the same counties are 15 to 25 bushels per acre, indicating again that the Miami clay loam is a preeminent wheat soil in this State. Complete commercial fertilizers are sometimes used with the wheat seeding; but in general the fertilizers incorporated with the soil in the preparation of the land for corn are chiefly relied upon for the production of the succeeding wheat crop. In many instances wheat is produced two years in succession, and the grass seeding is made with the second crop. In other instances oats are seeded for the second small grain crop, and the grass seeding is accomplished at that time.

The acreage devoted to oats in the counties of which soil surveys have been made, covering the Miami clay loam region of the east-central prairie States, is usually subordinate both to wheat and to corn, although in some instances the acreage devoted to oats is second only to that given to corn. Taking into consideration all the areas of which soil surveys have been made, in the region dominated by the Miami clay loam, census statistics show an average yield of over 35 bushels of oats per acre for these counties. In Indiana the average yields for the Miami clay loam are stated in the soil survey reports at 30 to 50 bushels per acre, while in Michigan and Ohio the average yields are stated at 40 to 60 bushels per acre. These estimates are fully verified by an examination of the statistics of yields in the counties concerned. As has been noted, oats frequently take the place of wheat as a second-year small grain crop. In other instances, particularly in Michigan and the northern part of Ohio, the wheat is entirely replaced by oats and this small grain is only seeded for a single year, being immediately followed by grass.

The area devoted to grass growing and hay production in the counties in which the Miami clay loam dominates and of which soil survey investigations have been made, almost equals the area devoted to the production of the grain crops. This arises from the fact that grass usually occupies the ground for two or three years in the regular rotation, being cut for hay during the first and second years and not infrequently pastured during the third year preparatory to breaking the ground for corn. The average yields for the counties in which these soil surveys have been made exceed 1.3 tons of hay per acre for the entire counties and again the Miami clay loam may be credited with a yield greater than the average for these counties. The soil survey reports give yields for this type ranging from 1 to 2 tons per acre and even the latter yield is sometimes exceeded. In all areas where the Miami clay loam occurs the rougher and more sloping portions of the type, together with many areas which may be

so covered with bowlders as to make cultivation difficult, are usually devoted to permanent pastures. The growth of native and tame grasses is excellent and many pastures have been maintained from 50 to 100 years without reseeding or the breaking of the sod.

Thus of the principal crops suited to the middle temperate region the Miami clay loam takes high rank in the production of corn, wheat, oats, hay, and pasturage grasses. It, therefore, constitutes one of the most important general-farming soil types in the eastern portion of the Central States.

In addition to the crops above mentioned, which dominate the agricultural practice of the region and the type, rye is also occasionally produced in Michigan, giving yields of 15 to 25 bushels per acre. Barley production is confined to southeastern Wisconsin and the yields reported vary from 25 to 40 bushels per acre. Beans also constitute an important crop in southern Michigan with yields of 10 to 22 bushels per acre and even the latter yield is sometimes exceeded. In central Indiana tomatoes are occasionally produced as a market-garden crop, yielding 200 bushels per acre, and in the same region green peas are raised for the city markets and as a canning crop, giving yields of about 50 bushels per acre. These constitute secondary special crops chiefly of local importance and produced because of local market conditions and demands.

In central and southern Michigan the Miami clay loam is also frequently used for the production of sugar beets. The crop takes the place of corn in the regular rotation and has been produced over an extensive acreage in this general locality. The yields produced vary from 8 to 15 tons per acre, and the beets usually show a high sugar content and high index of purity. The crop is only raised in the vicinity of established sugar-beet factories or in neighboring localities where transportation to the factories is well provided.

Another special crop produced upon the Miami clay loam is the Spanish Zimmer tobacco in the Miami region of southwestern Ohio. In this region when the tobacco is grown it usually follows the corn crop, and the Miami clay loam is considered the best soil in the area for the production of tobacco. Upon nearly every farm will be found small fields ranging in size from 3 to 8 acres, while the larger growers produce from 10 to 30 acres each year. The tobacco grown upon this soil has good body, good sweating properties, and is fine fibered and elastic. The best filler leaf produced in the region is grown upon the rolling upland areas of the Miami clay loam.

Among the tree fruits apples and pears are practically the only crops well suited to production upon the Miami clay loam, and even with apples it is necessary to discriminate in the selection of particular areas of the soil for the planting of orchards and also in the selection of varieties suited to such a heavy type of soil. It is only upon the

more rolling and better-drained uplands where both surface and internal drainage are excellent and where the air drainage over the orchard sites is also good that apple orcharding upon a commercial scale should be undertaken. Lower lying areas where water drainage is interrupted or where there is not a free circulation of air should be avoided for any extensive apple planting. The varieties best suited to planting upon this type are the old standard northern winter apples, the Rhode Island Greening and the Northern Spy. Of these, the Greening is rather better suited to production upon the Miami clay loam. Other minor varieties may be grown, but the chief commercial plantings should be of the varieties named.

The soil is altogether too heavy and the subsoil too dense for the production of peaches. Upon well-drained areas of the Miami clay loam the small fruits, particularly raspberries, currants, and strawberries, might well be grown, not only for home supply, but also for near-by city markets.

There has been very little development of market gardening or trucking upon the area of this type, with the single exception of a locality in central Indiana, where tomatoes and green peas dominate the crops grown. There would be an excellent opportunity for the production of cabbage and even of onions upon the lower lying portions of the type, especially where the dark-colored muck soil, which is frequently found in the hollows within the area of the type, has a depth of 6 to 8 inches or more.

In general, however, the Miami clay loam is too valuable as a grass and grain-producing soil to be devoted to special crops, except in such cases as possess unusual local market facilities, or unusual opportunities for rapid transportation to the larger cities. In fact, the value of this type for the production of corn, wheat, and grass has been so thoroughly recognized that these crops have practically excluded the growing even of oats.

As a result of the crop adaptations of the Miami clay loam, the proper disposal of the farm crops annually produced has led the majority of farmers into some form of animal production to supplement the sale of corn or wheat or other grain crops. In the State of Ohio and in southern Michigan dairying constitutes the chief form which this crop disposal takes. Both the corn and the hay are extensively fed to dairy cows, while the areas of pasturage are utilized for the summer production of milk. A considerable proportion of the milk is sold direct in the large cities, but creameries and cheese factories are also maintained for the manufacture of the greater part of the milk flow. In this connection young stock, calves, and swine are extensively fed for the purpose of a supplementary sale of beef, veal, and pork. It is within the area occupied by the Miami clay loam also that the principal sheep-breeding industry, which is still maintained in the eastern States, finds its place. The sheep are

now kept largely for the production of early spring lambs, although the wool clip constitutes an important item in the farm records of many areas where this type has been encountered. Not as many sheep are kept within this general region as in the older days of wool production, but the number now maintained is steadily increasing with the increased price of spring lambs.

FARM EQUIPMENT.

It would be totally impossible properly to till the Miami clay loam with lightweight farm teams or inadequate tools. This is thoroughly recognized throughout practically all areas where the type occurs, and as a result the heavy two-horse teams and the more powerful forms of farm machinery are prevalent. With these teams and implements deep plowing of the surface soil is possible, and thorough harrowing and tillage of the type can be conducted at all of the later stages. A large proportion of the crops planted or sown is placed in the ground by the use of the two-horse corn planter or the large size grain drill with fertilizer and seeder attachments. Disk harrows and the riding cultivators are also used extensively and the farm equipment is usually adequate and substantial.

Because of the prevalence of some form of stock raising within the territory occupied by the Miami clay loam, the farm buildings are large and substantial and the region is marked by well-painted houses, large and well-constructed hay and dairy barns, and in some portions, also, by the necessary equipment of well-built tobacco barns. Not infrequently the farms upon this type also possess the requisite equipment for the manufacture of maple sugar or sirup from the groves of sugar maples still remaining upon many of them. In fact, the general equipment of teams, tools, and buildings upon the Miami clay loam gives the appearance of well-stocked, adequately equipped, and well-cared-for farming territory.

SUMMARY.

The Miami clay loam is the most important of the timbered soils of the eastern portion of the Central States, both with respect to its areal extent and with regard to the variety and quantity of important staple crops produced.

It occupies the rolling, undulating, and sometimes hilly upland sections of southern Michigan, central and western Ohio, and eastern Indiana, and is also found to a limited extent in southern Wisconsin and some portions of Iowa. It lies at an altitude of 600 to 1,100 feet above tide level within the middle temperate zone of the Central States.

The surface soil is a rather heavy brown, yellow, or gray silty loam. The subsoil is a stiffer silty loam or clay. Both are derived from the surface weathering of deep deposits of ice-laid material. These

deposits generally have a depth of 40 to 150 feet, and consist of the mechanically ground up and complex rock fragments brought in from the north by glacial action and mingled with local material.

Over the greater proportion of its area the Miami clay loam is fairly well drained and in good physical condition. The more level areas and those somewhat remote from stream drainage, however, are considerably improved by the installation of tile drainage systems.

Corn, wheat, oats, and grass are the principal crops produced, and in the case of all four the yields reported are not only higher than the average yields of these crops for the United States, but are higher than the yields reported from the majority of other soil types in the same areas where the Miami clay loam has been encountered. Thus the Miami clay loam constitutes a prominent type for the production of corn, one of the best of the eastern soil types for the production of winter wheat, an excellent soil for the production of grass for hay or pasturage, and a good oat soil, although this crop is usually subordinate to the others mentioned.

Rye, barley, beans, tobacco, sugar beets, tomatoes, and green peas are also produced to advantage upon the Miami clay loam in certain localities.

A few varieties of apples may be grown upon those areas of the Miami clay loam possessing adequate air and water drainage. Small fruits may also be produced locally.

In addition to the sale of wheat and corn, a considerable proportion of the grain and hay raised upon the Miami clay loam is used for the feeding of dairy cattle, beef cattle, sheep and swine, and the type forms the foundation for an extensive dairy industry, particularly in Michigan and Ohio.

The heavier teams and tools and adequate farm buildings are not only required for the proper conduct of farming operations upon the Miami clay loam, but are also possessed by the majority of farmers engaged in its cultivation.

The price of farm lands made up chiefly of the Miami clay loam ranges from $50 or $60 per acre in the more remote locations to $125 or $150 per acre in more desirable situations.

Fully 80 per cent of the entire extent of the Miami clay loam is occupied by some form of tillage. The remaining area is either occupied by permanent pasturage, by woodlot, or by some other form of secondary occupation, due principally to local irregularities in slope or deficiency in drainage. It would therefore be impossible to extend to any great degree the area of agricultural occupation upon it. The principal improvements of the type must consequently result chiefly from improved methods of tillage operations upon this soil.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 10, 1911.*

APPENDIX.

The following table shows the extent of the Miami clay loam in the areas surveyed to this time.

In the first column is stated the particular soil survey in which the soil was encountered, in the second column its extent of development in acres, and in the third column the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of Miami clay loam encountered in the soil survey.

Survey.	Area of soil.	Year of publication, Field Operations.	Survey.	Area of soil.	Year of publication, Field Operations.
Indiana:	*Acres.*		Michigan—Continued.	*Acres.*	
Allen County	244,480	1908	Pontiac area	56,384	1903
Madison County	232,640	1903	Saginaw area	26,240	1904
Marion County	188,672	1907	Ohio:		
Marshall County	3,392	1904	Auglaize County	207,424	1909
Iowa:			Cleveland area	243,456	1905
Story County	13,376	1903	Columbus area	222,336	1902
Michigan:			Montgomery County	240,000	1909
Allegan County [1]	107,850	1901	Westerville area	267,264	1905
Alma area	6,144	1904	Wooster area	116,160	1904
Owosso area	62,464	1904	Wisconsin:		
Oxford area	12,160	1905	Racine County	31,040	1906

[1] Mapped as Allegan clay.